Manuscript Details

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Title	The environmental footprints of conservationists, economists and medics compared
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Abstract

Many conservationists undertake environmentally harmful activities in their private lives such as flying and eating meat, while calling for people as a whole to reduce such behaviors. To quantify the extent of our hypocrisy and put our actions into context, we conducted a questionnaire-based survey of 300 conservationists and compared their personal (rather than professional) behavior, across 10 domains, with that of 207 economists and 227 medics. We also explored two related issues: the role of environmental knowledge in promoting pro-environmental behavior, and the extent to which different elements of people's footprint co-vary across behavioral domains. The conservationists we sampled have a slightly lower overall environmental footprint than economists or medics, but this varies across behaviors. Conservationists take fewer personal flights, do more to lower domestic energy use, recycle more, and eat less meat - but don't differ in how they travel to work, and own more pets than do economists or medics. Interestingly, conservationists also score no better than economists on environmental knowledge and knowledge of pro-environmental actions. Overall footprint scores are higher for males, US nationals, economists, and people with higher degrees and larger incomes, but (as has been reported in other studies) are unrelated to environmental knowledge. Last, we found different elements of individuals' footprints are generally not intercorrelated, and show divergent demographic patterns. These findings suggest three conclusions. First, lowering people's footprints may be most effectively achieved via tailored interventions targeting higher-impact behaviors (such as meat consumption, flying and family size). Second, as in health matters, education about environmental issues or pro-environmental actions may have little impact on behavior. Last, while conservationists perform better on certain measures than other groups, we could (and we would argue, must) do far more to reduce our footprint.

Keywords	pro-environmental behavior; flying; meat consumption; energy saving; greenhouse gas emissions; environmental education
Taxonomy	Environmental Education, Conservation Biology

Corresponding Author	Andrew Balmford
Corresponding Author's Institution	Univ of Cambridge
Order of Authors	Andrew Balmford, Lizzy Cole, Chris Sandbrook, Brendan Fisher

Suggested reviewers	Richard Cowling, Sheila Walsh Reddy, David Wilcove, Richard Fuller

Submission Files Included in this PDF

File Name [File Type]

Cover letter.doc [Cover Letter]

Responses to Editor's comments.docx [Response to Reviewers]

Responses to comments.docx [Response to Reviewers]

Balmford et al. Highlights.docx [Highlights]

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Appendix A Questionnaire.pdf [Supporting File]

Appendix B Supplementary figures.pdf [Supporting File]

To view all the submission files, including those not included in the PDF, click on the manuscript title on your EVISE Homepage, then click 'Download zip file'.

Research Data Related to this Submission

There are no linked research data sets for this submission. The following reason is given:
The data that has been used is confidential

UNIVERSITY OF CAMBRIDGE
Department of Zoology

Andrew Balmford FRS
Professor of Conservation Science

12 January 2017

Dear Editors

I have pleasure in submitting our MS "The environmental footprints of conservationists, economists and medics compared" for consideration as a contributed paper in *Biological Conservation*. Given its content I'm not sure whether it would fit better as a Research Paper or a Perspectives piece, but for now have submitted it as the former.

It's an inter-disciplinary MS that takes as its starting point the growing number of observations that conservationists are worryingly hypocritical in the scale of their environmental footprints (Gremillet 2008 *Nature*; Bearzi 2009 *Conservation Biology*; Fox et al. 2009 *Frontiers in Ecology and the Environment*; Fraser et al. in press *Conservation Biology*). By carrying out what we think is probably the largest survey to date of conservationists' behaviour across multiple domains (from recycling and domestic energy use to flying, meat eating and family sizes) and comparing this with the responses of a broadly similar group of economists and medics we find that conservationist have a slightly lighter footprint, but not across all behaviours. Our data also reveal that despite working in the environmental sector, conservationists have no greater environmental knowledge than economists – and that variation in knowledge fails to predict people's footprints, which are more closely related to gender, nationality, occupation, age, education and income. Our results suggest that exposure to environmental information may have limited effect in lowering people's footprints, and that, while performing slightly better than some other groups, conservationists could do a great deal more to reduce their impacts, both professionally and personally. We close with some suggestions as to how.

The work is original research carried out by the authors, all of whom agree with the contents of the manuscript and its submission to *Biological Conservation*. No part of the research has been published in any form, and the MS is not being considered for publication elsewhere while it is being considered by you. There are no sources of funding to acknowledge. We explain in the MS that the research has obtained full ethical clearance.

I do hope you find our MS interesting, and are in due course able to accept it for publication in *Biological Conservation*.

Yours sincerely

Andrew Balmford

Downing Street
Cambridge CB2 3EJ

Tel: +44 (0) 1223 331770
Fax: +44 (0) 1223 336676
Email: a.balmford@cam.ac.uk
www.zoo.cam.ac.uk

Responses to Editor's comments

Thank you very much for your positive letter earlier this month. I'm submitting a revised version of the MS which I hope deals with your points; it also includes a few additional clarifications and references.

Specifically:

1. Please end your abstract with a shorter sentence (cut the last long phrase and end with a straightforward take home message).

The last sentence of the Abstract has now been split to make it easier to read, and to close on stronger closing message:

"These findings suggest three conclusions. First, lowering people's footprints may be most effectively achieved via tailored interventions targeting higher-impact behaviors (such as meat consumption, flying and family size). Second, as in health matters, education about environmental issues or pro-environmental actions may have little impact on behavior. Last, while conservationists perform better on certain measures than other groups, we could (and we would argue, must) do far more to reduce our footprint."

2. Re. "Conservation is fundamentally about changing people's behavior" - I tend to agree but this claim is quite strong … Whether a conservation biologist working on protected area effectiveness or trying to understand the metapopulation dynamics of a given species can/should "change" people's behaviour is not obvious.

All authors share the view of conservation being fundamentally about changing human behaviour (and have published it separately in quite a few papers over the past 10 or 15 years). Of course we also appreciate your point, but suspect your argument is more true of conservation biology (or perhaps conservation science) than about conservation in the round. We would argue that even where an activity is solely focused on biological management of a reserve, effective conservation hinges on a practitioner behaving in a particular way; it will nearly always also depend on behaviour change by others (farmers, tourists, consumers…). Given this, if possible we would very much like to keep this statement as it is.

3. Line 80 - In this sentence, can you please attach each reference to the issue considered instead of making the list and then 11 references.

We've now done this, so it reads (from new line 82):

"Instead, it seems many other psychological and societal factors also influence the expression of pro-environmental behaviors - including values (the importance individuals attach to issues; Bolderdijk et al., 2013; Gromet et al., 2013; Li et al., 2016; Reddy et al., 2017); social norms (and the role of consumption in social signalling; Bamberg and Möser, 2007; Csutora, 2012; Jackson, 2004; Kahan et al,. 2012; Kollmuss and Agyeman, 2002; Reddy et al., 2017; Steg and Vlek, 2009; Thøgersen, 2014; Vermeir and Verbeken, 2008); structural, cognitive and economic constraints (which may make more sustainable alternatives unavailable; Csutora, 2012; Gifford and Nilsson, 2014; Jackson, 2004; Kennedy et al., 2009; Kollmuss and Agyeman, 2002); individuals' perceptions of their control over outcomes (Bamberg and Mõser, 2007; Gifford and Nilsson, 2014; Hines et al., 1987; Kennedy et al., 2009l Kollmuss and Agyeman, 2002); people's ingrained habits (Jackson, 2004; Steg and Vlek, 2009; Thøgersen, 2014); and so-called choice architecture (the way in which alternatives are presented,

with easier, more attractive or default options often perpetuating the status quo; Marteau, 2017; Reddy et al., 2017; Sunstein and Reisch, 2014)."

4. On toning down (a bit) the claim that conservationists are to some extent guilty of hypocrisy
We have changed the text in a couple of places. New line 47 now reads
"Conservationists fly, sometimes a lot more than our fellow citizens…" (cf "Conservationists fly, often a great deal more than our fellow citizens");
and new line 374 now reads:
"…our results show that – while performing better on certain measures (include some that are high-impact) than do our other groups – as conservationists we could nevertheless do a great deal more to reduce our footprint." (cf "…our results show that – while performing better on certain measures than our other groups – as conservationists we could nevertheless do a great deal more to reduce our footprint.").

I hope this and our other changes are acceptable.

With best wishes
Andrew Balmford

Responses to Reviewer 1 comments

We thank the Reviewer for their very extensive comments. We agree with many, disagree with some, and set out below our responses to each point, as well as the corresponding changes we have made in the revised version of our MS.

Theory and hypotheses (and Abstract, point 2; and Introduction, point 2). The reviewer would like to see more of a review of the literature relating environmental behaviours to occupation or socio-economic variables, and would like us to present underlying hypotheses, and a detailed theory of change. We feel that we already do introduce quite a lot of the literature underlying our study. We also appreciate that in psychology journals presenting findings within a framework of theory is the norm. However, our aim here (as in many other papers in Biological Conservation) is not primarily to advance theory but to present novel data in an attempt to answer three questions of considerable applied relevance: whether conservationists have lighter environmental footprints than other professionals; whether greater environmental knowledge is associated with greater pro-environmental behaviour; and whether people's footprints co-vary across behavioural domains. We make an effort to introduce each topic with a review of the relevant literature (e.g. the Reviewer specifically asks for citations to work on correlations between pro-environmental behaviours and socio-economic variables, yet we already cite four studies on this, in the second para of the Introduction) – though we realise though that much of this literature is not couched in terms of hypotheses or theories of change. We don't know of any papers on the specific question of links between occupations, knowledge and behaviours, but have elaborated on our underlying logic in the Introduction (see *Introduction point 4* below). We suggest that a wider, more theory-based literature review would be inappropriate for what is essentially an applied, data-based paper.

Methods and measurement

a. On justification for our knowledge and behaviour variables. We've tried to strengthen this aspect of the paper quite a lot.

We've added some explanation about our selection of behaviour/footprint measures to the second para of the Introduction (WITH NEW TEXT FLAGGED HERE IN CAPITALS):

"we quantified people's actions across 10 diverse behavioral domains, from recycling to having children, CONSIDERED TO BE RELEVANT TO ENVIRONMENTAL IMPACT AND OVER WHICH WE SUGGEST INDIVIDUALS HAVE AT LEAST SOME DEGREE OF CONTROL."

We've also added substantial text and 10 new citations to the second para of the Methods, justifying our choice of outcome variables, but also explaining that they do not provide a comprehensive assessment of our respondents' footprints:

"Our key behavioral questions (Table 1) asked participants ABOUT SEVERAL BEHAVIOURS KNOWN TO CAUSE NEGATIVE OR POSITIVE ENVIRONMENTAL IMPACTS: whether they walked, cycled or used public transport to get to work (ERCAN ET AL. 2016); how often they flew (for work or personal

reasons, which we analysed separately; MIYOSHI AND MASON, 2016); energy-saving measures in their homes (DIETZ ET AL. 2009); whether they offset their energy or travel footprint (GOSSLING ET AL. 2009); their level of recycling and composting (HERMANN ET AL. 2011); their production of food waste (GARNETT, 2011); their consumption of meat or fish (TILMAN AND CLARK, 2014); their use of bottled water (BOTTO ET AL. 2011); the number of children they have (or hope to have; MURTAUGH AND SCHLAX, 2009); and their ownership of cats and dogs (RAVILIOUS, 2009). We also invited respondents to give reasons for their answers. WHILST THE DOMAINS WE SELECTED DO NOT ENABLE US TO CARRY OUT A COMPREHENSIVE ENVIRONMENTAL FOOTPRINT, THEY DO GIVE US A BROAD INDICATION OF RESPONDENTS' RELATIVE ENVIRONMENTAL PERFORMANCE AND ALLOW US TO INVESTIGATE CORRELATIONS BETWEEN DIFFERENT BEHAVIOURS."

On our knowledge questions, we have used similar questions in two previous papers – Balmford et al. 2004 Science 305: 1713 and Fisher et al. 2009 Oryx 43: 361.

These questions from the Reviewer also link to *Methods points 2-5 and point 15* – about survey piloting, question reliability, and Cronbach's alpha. Please see our responses to those more detailed points below.

b. On why we chose to focus on personal (cf professional) behaviours? (also raised in points a and b under Framing,discussion and conclusions; in point 7 under Methods, "The measures missed professional behaviors…"; and point 9 under Discussion, "The study did not survey… professionals on how they may be helping to change systems"). We apologise for being unclear about our focus. The professional impacts of conservationists are of great interest, but are not the target of this study, which instead explores how far conservationists – who are more exposed to arguments for pro-environmental behaviour than other groups, and who often urge others to change their behaviour – exhibit environmentally-friendly behaviour in their personal lives. This is an important issue, because if conservationists do not have substantially lower impacts, this suggests that increasing exposure of other groups to environmental messages may by itself have limited benefits. We have altered the MS to emphasize our focus on personal behaviours, in both the Abstract:

"Many conservationists continue to engage in environmentally harmful activities IN THEIR PRIVATE LIVES, such as flying and eating meat, WHILE CALLING ON SOCIETY AT LARGE TO REDUCE THESE ACTIVITIES"; and

"…we conducted a questionnaire-based survey of 300 conservationists and compared ASPECTS OF THEIR PERSONAL (CF PROFESSIONAL) behavior, across 10…"

and in the Introduction:

"actively (and visibly) adopting pro-environmental behaviors IN THEIR PERSONAL LIVES in order to lower…".

It is of course possible that conservationists' professional actions have environmental benefits that outweigh their personal footprints, but that is a separate issue, and one which we do not attempt to examine here.

c. On the importance of self-selection and social desirability bias (also raised by Methods point 13 below). We agree with the reviewer that our assumption that these are consistent across our groups is rather weak. We have therefore changed the relevant section of the Methods:

"we are therefore relying on the weaker assumption that any biases are relatively consistent across respondents (BUT SEE DISCUSSION)"

to draw attention to an expanded consideration of this problem in the Discussion:

"Our assessment of variation in their footprints relies on self-reporting, and therefore on the assumption that the biases this induces are similar across different groups. IT IS POSSIBLE OF COURSE THAT CONSERVATIONISTS ARE DISPROPORTIONATELY AFFECTED BY SOCIAL DESIRABILITY BIAS BECAUSE THEY KNOW MORE ABOUT PRO-ENVIRONMENTAL ACTIONS THAN (SOME) OTHERS, AND WISH TO APPEAR AS RESPONSIBLE CITIZENS. IF SO, THIS SUGGESTS THE BEHAVIOR DIFFERENCES BETWEEN CONSERVATIONISTS AND OUR OTHER GROUPS ARE EVEN LESS MARKED THAN WE OBSERVED."

Length constraints make it very difficult to draw out the implications of social desirability bias in the Abstract, but we feel we have now explored the issue at sufficient length in the body of the MS.

d. We should focus primarily on the results from our GLMs (also raised by point 4 under Abstract, point 2, point 3 and point 4 under Results, and point 3 under Discussion). We disagree with the reviewer on this point. At its simplest our study is a phenomenological assessment of whether conservationists' behaviour differs from that of other groups. (Our first question is "Do conservationists have a lower footprint than other people?") As such a simple univariate set of comparisons is entirely appropriate (by analogy, if we are interested in whether elephants differ in body mass from mice we don't need first to control for differences in longevity and diet). We are also interested in understanding why the patterns we see arise, and hence we next build and present many GLMs which explore associations between behaviours and a suite of predictors reported in the literature. To the extent one can infer causations from such correlations (which we are very reluctant to do), these suggest that some of the differences between conservationists and other groups may arise because of differences among our groups in income, gender, etc. – but they do not mean that the differences observed in the univariate analyses do not exist. For this reason, and because it is more logical for the reader to see the univariate results before the GLMs, we have retained the order of the Results. However, we have also increased the profile of the GLM results by adding to the first major point of the Discussion:

"Conservationists have a somewhat lower environmental footprint than economists or medics, but this DIFFFERENCE varies across behaviors, is not the case for travelling to work or pet ownership, AND IS FURTHER WEAKENED IN GLMs THAT TAKE INTO ACCOUNT SOCIO-ECONOMIC VARIATION ACROSS OUR SAMPLED GROUPS."

Framing, discussion and conclusions

a. On barriers limiting pro-environmental behaviours. We agree this may be part of the explanation for the absence of a link between environmental knowledge and pro-environmental behaviour, which is why we write in the Discussion:

"These results mirror those from other environmental studies and from the health sector which indicate that the effects of income, social norms, habits, infrastructure and choice architecture may all be more important than knowledge in shaping our behavior."

However, we consider it beyond the scope of a survey-based paper to then go on to review examples of other ways of shifting environmentally-sensitive behaviours. Two of the authors are involved in a separate 8000-word review of this topic, but it is not the focus of this MS.

b. On focusing on conservationists' professional behaviours. See *Methods and measurement point b* above.

c. On the Abstract going beyond the strength of the evidence. See *Abstract points 7 and 8* below.

Abstract

1. Acknowledging the lack of correlation between attitudes and actions in the Abstract. We have now changed the Abstract text to read:

"overall footprint scores are higher for males, US nationals, economists, and people with higher degrees and larger incomes, but (AS HAS BEEN REPORTED IN OTHER STUDIES) show no relationship with environmental knowledge."

2. On the need to set up theory and hypotheses. See *Theory and hypotheses* above.

3. Hypocrisy may not accurately reflect the situation. Hypocrisy is defined as "the behavior of people who do things that they tell other people not to do". It seems that in undertaking environmentally damaging behaviours while calling on society as a whole to change its behaviour, conservationists are indeed, on the average, behaving hypocritically. The Reviewer might perhaps argue that conservationists face such great barriers that they have no choice in how they behave – but the evidence of enormous within-group variation in behaviours reported in our survey confirm the common-sense intuition that people have considerable ability to choose how much meat to eat, how often to take personal flights, or whether they own a dog. We have added a small section to the second para of the Introduction to clarify our position on this:

"we quantified people's actions across 10 diverse behavioral domains, from recycling to having children, CONSIDERED TO BE RELEVANT TO ENVIRONMENTAL IMPACT AND OVER WHICH WE SUGGEST INDIVIDUALS HAVE AT LEAST SOME DEGREE OF CONTROL."

4. On socio-economic variables explaining variation in behaviour. See *Methods and measurement point d* above.

5. On saying more about likely biases in the Abstract. Length constraints make this difficult, but see *Methods and measurement point c* above for how we have expanded this point in the Discussion.

6. On whether we looked at people's entire footprints. This would be impossible in a simple survey such as this, but we think this is clear from the wording of the Abstract, where we say we surveyed people's behaviour across 10 domains, which we equate to "different elements of people's footprint".

We've now underscored it in the second para of the Methods by adding:

"WHILST THE DOMAINS WE SELECTED DO NOT ENABLE US TO CARRY OUT A COMPREHENSIVE ENVIRONMENTAL FOOTPRINT, THEY DO GIVE US A BROAD INDICATION OF RESPONDENTS' RELATIVE ENVIRONMENTAL PERFORMANCE AND ALLOW US TO INVESTIGATE CORRELATIONS BETWEEN DIFFERENT BEHAVIOURS."

7. On how a recommended focus on high-impact behaviours follows from our results. The argument is that behaviours differ enormously in their environmental impact (paragraph 2 of section 3.1), but changes in one domain are rarely correlated with shifts in others. It therefore seems logical that efforts should focus on interventions targeting behaviours of high impact. We've added a little to the key Discussion sentence on this point:

"Our results provide no indication that encouraging relatively easy BUT LOW-IMPACT behavioral changes (such as increased recycling) is likely to lead to shifts in other domains, and we instead suggest efforts should focus on devising audience-specific interventions targeting those behaviors with greatest environmental impact."

8. Conclusions re. the knowledge-attitude gap are not new. We now explicitly acknowledge this point in the Abstract (see *Abstract point 1* above).

Introduction

1. Conservationists may be unable to change their behaviours because they are stuck in the same systems as others. We agree that infrastructure and choice architecture may constrain everyone's behaviours to some degree (see *Framing, discussion and conclusions point a* above). However we believe that conservationists are far from being completely constrained (see *Abstract point 3* above, and *Discussion point 10* below), and that it is not unreasonable to expect them to show considerably greater pro-environmental behaviour than others, in many behavioural domains.

2. Wanting to see more of a detailed theory of change. See *Theory and hypotheses* above.

3. More on why our comparison groups are similar. We don't claim great similarity, but have tried to clarify this by changing the sentence to read:

"we extended our sample to two other groups with BROADLY similar educational and APPLIED characteristics…"

We did not limit ourselves to particular sectors, merely to people who responded to requests to participate which were distributed by conservation, economics and biomedical organisations.

4. On the assumption that conservationists have been exposed to environmental information for longer than people in our other groups. Thanks for pointing out this lack of clarity. We have now made this step in the logic explicit:

"WE EXPECT THAT THROUGH THEIR JOBS AND/OR INTERESTS THE CONSERVATIONISTS WE SAMPLED HAVE EXPERIENCED MUCH LONGER-TERM EXPOSURE TO ENVRIONMENTAL INFORMATION THAN OUR OTHER RESPONDENTS. We therefore used our comparison of conservationists with other groups to examine associations between SUCH exposure, environmental knowledge and pro-environmental behaviors, adjusting as far as possible for the effects of other factors."

5. On the need to flag the limitations of a correlational study. We agree, and have added a final sentence to this paragraph:

"AS WITH OTHER ASPECTS OF OUR STUDY, HOWEVER, WE RECOGNISE THAT ADOPTING A NON-EXPERIMENTAL, CORRELATIONAL APPROACH LIMITS OUR ABILITY TO UNDERSTAND THE CAUSALITY OF THE PATTERNS WE OBSERVE."

Note that we also make this limitation very clearly in the Discussion, highlighting it as our third and most important caveat.

6. Provide a review of literature on co-variation in different aspects of people's environmental footprints. Providing a full review here would be impractical, but we have added a sentence and citations:

"are the predictors of different behaviors similar across domains? EVIDENCE FOR SUCH CO-VARIATION IS SO FAR RATHER WEAK (E.G. ALCOCK ET AL. 2017; BARR ET AL., 2010; PAINTER ET AL., 1983). To the extent there are congruent patterns…"

Methods

1. Be clearer about this being a non-random sample. We have added a sentence on this to the first paragraph of the Methods:

"RESPONDENTS WERE SELF-SELECTED AND THUS (AS IN MOST STUDIES OF THIS NATURE) WERE A NON-RANDOM SAMPLE."

This also addresses *Methods point 14* below.

2. Was the survey piloted? We have now clarified this in the first para of the Methods:

"After PILOTING THE SURVEY ITERATIVELY WITH 36 UNDERGRADUATE AND GRADUATE STUDENTS AT THE UNIVERSITIES OF CAMBRIDGE AND VERMONT and receiving approval from…."

3. Reliability. See the detailed discussion of Reliability and Cronbach's alpha under *Methods point 15* below.

4. Use of questions from other surveys. We have used similar knowledge questions in two previous papers – Balmford et al. 2004 Science 305: 1713; Fisher et al. 2009 Oryx 43: 361.

5. Question development. See answers to *Methods point 2 and point 4* above.

6. Did we ask enough to make a comprehensive footprint estimate? No – this would impractical for a sample of this size; instead we focused on a few relatively measurable behaviours which have high footprints or a high profile in environmental campaigns. We hope this focus is clear right from the abstract:

"we … compared … behaviour, across 10 domains ….. and the extent to which different elements of people's footprint co-vary…"

We've now underscored it in the second para of the Methods by adding:

"WHILST THE DOMAINS WE SELECTED DO NOT ENABLE US TO CARRY OUT A COMPREHENSIVE ENVIRONMENTAL FOOTPRINT, THEY DO GIVE US A BROAD INDICATION OF RESPONDENTS' RELATIVE ENVIRONMENTAL PERFORMANCE AND ALLOW US TO INVESTIGATE CORRELATIONS BETWEEN DIFFERENT BEHAVIOURS."

7. Our measures missed professional behaviours. See *Methods and measurement point b*, above.

8. Did we screen out respondents? No we did not. But we realise this question may have arisen because we omitted the legend Appendix A (the questionnaire). We used three very slightly different versions of the questionnaire, with the wording of question 6 (Do you consider yourself a professional, a practitioner, a researcher?) tailored to the group receiving the invitation to participate. For conservationists the question asked Do you consider yourself a conservation professional, a conservation practitioner, a conservation researcher? For economists it asked Do you consider yourself an economics professional, an economics practitioner, an economics researcher? And for medics it asked Do you consider yourself a biomedical professional, a biomedical practitioner, a biomedical researcher? We have now added the legend to Appendix A:

"**Appendix A. Questionnaire.** All respondents received an identical questionnaire, except that question 6 ("Do you consider yourself to be … a professional in the XXX sector, a XXX practitioner, a XXX researcher?") varied across groups, such that XXX read "conservation", "economics" or "biomedical", depending on the organisation through which the respondent was contacted. We present the conservationist version here."

9 and 10. How did we classify economists, medics and conservationists? We have now added a sentence on this to the first paragraph of the Methods:

"WE ASSIGNED RESPONDENTS TO OUR THREE GROUPS SIMPLY BASED ON WHETHER THEY RESPONDED TO A COMMUNICATION FROM A CONSERVATION, AN ECONOMICS OR A BIOMEDICAL ORGANISATION."

11. Did economists and medics say yes to being conservation professionals? As explained in *Methods point 8* they were only asked if they were economics or biomedical professionals, respectively. We apologise for the confusion.

12. The questions about environmental knowledge primarily pertain to knowledge of issues but not how to change behaviour. Is this a problem for examining the link between knowledge and action? We don't think so. As explained in the Methods we asked a separate multi-part question about what

actions could reduce the average citizen's footprint, and analysed correlations between people's behaviours and their score for that question (which we term "knowledge of pro-environmental actions") entirely separately to correlations between their actions and their score for knowledge of issues (which we term "environmental knowledge").

13. Conservationists are more likely to have social desirability bias. See *Methods and measurement point c* above.

14. Bring up sample unrepresentativeness earlier. We now do – see *Methods point 1* above.

15. Reliability and Cronbach's alpha. Cronbach's Alpha is used to see if items in a set reliably measure the same construct, but a person's environmental footprint is in our view unlikely to lend itself to a single instrument whose terms have internal validity. Unlike with instruments such as the Connectedness to Nature Scale, we would actually not expect the items we measured to covary. Indeed there are behavioural patterns and behaviours (e.g. moral licensing; status quo bias) that predict that we would expect to see little correlation across different footprint-related behaviours. Hence Cronbach's Alpha does not seem like a valid test for our instrument, as our items are trying to capture a suite of impacts, but not trying to establish reliability across answers. Nonetheless to satisfy the Reviewers we did run a test to measure Cronbach's Alpha. The standardized Alpha is 0.34, suggesting that (as predicted) our instrument cannot be purported to have high tau-equivalent reliability.

16. We should not talk about predictors without providing evidence of causality. In our view this is point is simply incorrect – to describe something as a predictor of variation in a variable is not to say it is the cause of that variation. This answer also applies to *Discussion point 4* below.

Results

1. How do the results compare with those from representative surveys? This a good question which is impossible to answer as we are aware of no surveys asking these questions which involve truly representative sampling.

2-4. Wanting to see the GLM results first. Please see detailed explanation under *Methods and measurement point d* above.

5. Wanting a citation to low r^2-values being quite common in analyses of human behaviour. We have added a citation to Abelson 1985. A variance explanation paradox: when a little is a lot. Psychological Bulletin 97: 129-133 .

6. Is lack of control over work flights typical of the other behaviours we measure here? As explained under *Abstract point 3*, we suggest that, although people will be making personal behaviour choices under some constraints, they nevertheless can be expected to have some degree of control over the measures we examine.

7. Role of institutions. See response to *Abstract point 12* below.

8. On whether people flying more for work and for personal reasons could both be explained by income. This is plausible, as income is a strong predictor of both behaviours (see Fig. 3). *On whether place of residence explains both pet-owning and how people get to work.* We can't tell, as we didn't collect detailed information on where people live.

9. On explanation of people flying more having more pets. We agree this co-variation might well be explained by factors other than environmental knowledge: that is indeed our conclusion to this entire section:

"Higher environmental knowledge and knowledge of pro-environmental actions were both associated with a lower footprint in how people get to work, but showed very limited links to any other behaviors."

Discussion

1. On possible explanations for the interaction term with environmental importance. We suggest the most plausible explanation is that economists often know quite a lot about the environment and the actions they could take to reduce their footprint, but generally attach less importance to the environment than conservationists – and hence only share their slightly lower overall footprint if they have a similar environmental importance score. However, this interpretation is speculative, and deals with a rather minor result, so we would prefer to omit it and focus the Discussion on the answers to our questions, and our main caveats. If essential we could add a phrase either to the relevant part of the Results, or to the legend to Fig. 2.

2. What did the solicitation for the survey look like and how could it bias results? The message posted in newsletters on social media groups read:

"Dear member

In recent decades environmental issues have received more and more attention - in the media, in politics and in research. We are conducting a survey on the environmental impact of people's lifestyles and their knowledge of environmental issues and would like to invite you to take part. A link to the survey can be found here. It should take you around 5 minutes to complete.

The study is being organised by a joint team of natural and social scientists from the University of Cambridge (Professor Andrew Balmford, Dr Chris Sandbrook, Lizzy Cole) and the University of Vermont (Professor Brendan Fisher).

All responses will remain anonymous with no names or other identifying features recorded, unless you wish us to contact you with the results of the study All information will be held in accordance with the UK Data Protection Act 1998. Respondents can exit the survey at any point, and incomplete survey data will not be used for analysis.

If you have any questions about the survey please feel free to contact the authors at environment_and_you@yahoo.com. Many thanks for taking the time to read this and complete this survey."

We do not think this wording could have led to differences in survey responses across our groups, though of course cannot rule this out.

3. Our conclusion that conservationists have a somewhat lower footprint may be misleading because other variables explain these differences. As discussed under *Measurement and methods point d*, we largely disagree with the reviewer on this. Within our sample conservationists do have a slightly lower footprint (just as elephants are heavier than mice); asserting a difference is not the same as explaining it. But here are several caveats to this statement – hence it begins "Our results suggest…"; it goes on to say:

"Conservationists have a somewhat lower environmental footprint than economists or medics, but this DIFFERENCE varies across behaviors, is not the case for travelling to work or pet ownership, AND IS FURTHER WEAKENED IN GLMs THAT TAKE INTO ACCOUNT SOCIO-ECONOMIC VARIATION ACROSS OUR SAMPLED GROUPS";

and it is immediately followed by a paragraph about self-selection and social desirability bias, unmeasured aspects of people's footprints, and the perils of correlational analyses.

4. Using the word predictions to describe correlations. As discussed under *Methods point 16*, this is standard practice.

5. Our point is hard to read. Thanks for bringing this to our attention. We have now split the sentence to improve clarity. It now reads:

"Variation in people's combined footprint is independently predicted by their gender, nationality, occupation, education, income and the value which they attach to the environment – but not by their environmental knowledge or knowledge of pro-environmental actions. INDEED BOTH OUR KNOWLEDGE MEASURES are no greater among conservationists than economists."

We obscured the point that knowledge is lower among conservationists than economists. It is not, on either score. We hope this is now clearer. We also spell out our knowledge results in the Abstract, and in Results section 3.2.

6. Our sample is a non-random subset of a non-random sample of people. We agree. We now say more about the people invited to participate being non-random (see answer to *Methods point 1*) – and the Reviewer's point about those choosing to respond being a non-random subset of those contacted is the first of our major caveats in the Discussion.

7. Frame this as exploratory, baseline or descriptive. We have done so, now saying:

"Yet despite these caveats, and because this is APPARENTLY THE FIRST wide-ranging DESCRIPTIVE survey of the relative footprint of conservationists to date, we believe some cautious inferences can still be made."

8. Say more about the unintended negative effects of environmental messaging. We have now added some text:

“Indeed there is now growing OBSERVATIONAL AND experimental evidence that among audiences with negative attitudes to the environment, greater knowledge and environmental messaging can even prompt a reduction in pro-environmental behavior (AS SEEN IN STUDIES OF THE EFFECTS OF ENVIRONMENTAL PRODUCT LABELLING ON CONSERVATIVE CONSUMERS, AND OF THE POPE'S LAUDATO SI ENCYLCICAL ON CONSERVATIVE CATHOLICS - Dietz et al., 2013; Gromet et al., 2013; Kahan et al., 2012; Li et al., 2016).

9. We could foreshadow the issues of structural constraints and choice architecture in the Introduction. We already do – in the third paragraph:

“Instead, it seems many other psychological and societal factors also influence the expression of pro-environmental behaviors - including … structural, cognitive and economic constraints (which may make more sustainable alternatives unavailable); individuals’ perceptions of their control over outcomes; people’s ingrained habits; and so-called choice architecture (the way in which alternatives are presented, with easier, more attractive or default options often perpetuating the status quo).”

The study did not survey how professional activities may help change systems. This was never our aim. See response to *Measurement and methods point b* above.

10. Could conservationists do more? We think they could. There are of course constraints and counter-incentives, but quite a few of the conservationists we surveyed choose to eat less meat and fly less (for work as well as pleasure); some offset their flight emissions; and some even opt for fewer children for pro-environmental reasons. We thus stand by our point (reiterated under *Abstract point 3 above*) that “as conservationists we could … do a great deal more to reduce our footprint.”

11. Citation for “We think that trying to lead by example is key to encouraging and sustaining fundamental society-wide changes in behavior.”. We’ve never before been asked to provide a citation for a “We think …” statement in a Discussion.

12. Give tangible examples of efforts of changing the way we interact. We’ve added a citation to the really interesting example of the Flying Less blog, which specifically targets academics:

“attending frequent international meetings is no longer regarded as essential to making scientific or personal progress (see also Fraser et al., 2016; AND THE FLYING LESS INITIATIVE - FLYING LESS, N.D.).

13. Make the point that conservationists could help create offset programmes that support biodiversity. The final phrase now reads:

“and offsetting our residual footprints (preferably through CREATING AND SUPPORTING projects that generate biodiversity co-benefits) rather than continuing to pass on the impacts of our residual footprint to future generations and other species.”

Highlights

conservationists often engage in environmentally harmful behaviors

we found they have slightly lower footprints than comparable groups, but only in some domains

footprints did not shrink with increasing environmental knowledge

different elements of people's footprints did not co-vary

exposure to environmental information may have little impact on pro-environmental behavior

The environmental footprints of conservationists, economists and medics compared

Andrew Balmford[a,*], Lizzy Cole[a], Chris Sandbrook[b,c] & Brendan Fisher[d,e]

[a] Conservation Science Group, Dept of Zoology, University of Cambridge, Downing St, Cambridge CB2 3EJ, UK

[b] UN Environment World Conservation Monitoring Centre, 219 Huntingdon Rd, Cambridge CB3 0DL, UK

[c] Dept of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN, UK

[d] Environmental Program, Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, Vermont 05405, USA

[e] Gund Institute for Environment, University of Vermont, 617 Main St, Burlington, Vermont 05405, USA

* Corresponding author. E-mail address: a.balmford@zoo.cam.ac.uk

Abstract

Many conservationists undertake environmentally harmful activities in their private lives such as flying and eating meat, while calling for people as a whole to reduce such behaviors. To quantify the extent of our hypocrisy and put our actions into context, we conducted a questionnaire-based survey of 300 conservationists and compared their personal (rather than professional) behavior, across 10 domains, with that of 207 economists and 227 medics. We also explored two related issues: the role of environmental knowledge in promoting pro-environmental behavior, and the extent to which different elements of people's footprint co-vary across behavioral domains. The conservationists we sampled have a slightly lower overall environmental footprint than economists or medics, but this varies across behaviors. Conservationists take fewer personal flights, do more to lower domestic energy use, recycle more, and eat less meat - but don't differ in how they travel to work, and own more pets than do economists or medics. Interestingly, conservationists also score no better than economists on environmental knowledge and knowledge of pro-environmental actions. Overall footprint scores are higher for males, US nationals, economists, and people with higher degrees and larger incomes, but (as has been reported in other studies) are unrelated to environmental knowledge. Last, we found different elements of individuals' footprints are generally not intercorrelated, and show divergent demographic patterns. These findings suggest three conclusions. First, lowering people's footprints may be most effectively achieved via tailored interventions targeting higher-impact behaviors (such as meat consumption, flying and family size). Second, as in health matters, education about environmental issues or pro-environmental actions may have little impact on behavior. Last, while conservationists perform better on certain measures than other groups, we could (and we would argue, must) do far more to reduce our footprint.

Keywords

pro-environmental behavior, flying, meat consumption, energy saving, greenhouse gas emissions, environmental education

1. Introduction

Conservationists fly, sometimes a lot more than our fellow citizens (Fox et al., 2009; Grémillet, 2008). We buy a lot of computers; and some of us – even some marine experts - eat swordfish (Bearzi, 2009). These specific examples highlight a much broader and deeply worrying issue.

Conservation is fundamentally about changing people's behavior. As such, conservationists should be in the vanguard – actively (and visibly) adopting pro-environmental behaviors in their personal lives in order to lower our own footprints as much as possible. Failure to do so risks undermining the credibility of the conservation movement. Documenting and understanding our failings, however, might also help identify ways of catalysing and accelerating change across society as a whole.

With this in mind we conducted a wide-ranging questionnaire-based assessment of the environmental footprint of individuals linked to conservation groups (hereafter "conservationists"). Because it is possible that the published examples of conservationists' excess are exceptional and do not generalise, we quantified people's actions across 10 diverse behavioral domains, from recycling to having children, considered to be relevant to environmental impact and over which we suggest individuals have at least some degree of control. Because many other variables impact pro-environmental behaviors – most obviously demographic attributes such as age, gender and income (Alcock et al., 2017; Csutora, 2012; Gatersleben et al., 2002; Gifford and Nilssen, 2014; Jones and Kammen, 2011; Kollmuss and Agyeman, 2002) - we also collected information on these variables, and adjusted our assessments of conservationists' footprints to take them into account. And to help put these findings into context, we extended our sample to two groups with broadly similar educational and applied characteristics – those linked to economics and to biomedical groups (hereafter "economists" and "medics" respectively).

Conservationists might be expected to know more about environmental problems and solutions than these other groups, so this comparison also enabled us to explore one of the core notions of environmental education: that enhanced knowledge promotes greater pro-environmental behavior. Despite observed associations between knowledge and actions (Bamberg and Möser, 2007; Hines et al., 1987), the correlational evidence for this intuitive premise is complex. The essentially linear idea that enhanced knowledge promotes greater awareness in turn triggering pro-environmental behavior is no longer accepted (yet as Kollmuss and Agyeman [2002] point out, still forms the basis of many NGO and government communications campaigns). Instead, it seems many other psychological and societal factors also influence the expression of pro-environmental behaviors - including values (the importance individuals attach to issues; Bolderdijk et al., 2013; Gromet et al., 2013; Li et al., 2016; Reddy et al., 2017); social norms (and the role of consumption in social signalling; Bamberg and Möser, 2007; Csutora, 2012; Jackson, 2004; Kahan et al,. 2012; Kollmuss and Agyeman, 2002; Reddy et al., 2017; Steg and Vlek, 2009; Thøgersen, 2014; Vermeir and Verbeken, 2008); structural, cognitive and economic constraints (which may make more sustainable alternatives unavailable; Csutora, 2012; Gifford and Nilsson, 2014; Jackson, 2004; Kennedy et al.,

2009; Kollmuss and Agyeman, 2002); individuals' perceptions of their control over outcomes (Bamberg and Mõser, 2007; Gifford and Nilsson, 2014; Hines et al., 1987; Kennedy et al., 2009l Kollmuss and Agyeman, 2002); people's ingrained habits (Jackson, 2004; Steg and Vlek, 2009; Thøgersen, 2014); and so-called choice architecture (the way in which alternatives are presented, with easier, more attractive or default options often perpetuating the status quo; Marteau, 2017; Reddy et al., 2017; Sunstein and Reisch, 2014). Experiments offer some scope for isolating the effects of knowledge from these other factors, but where knowledge effects have been identified they often appear specific to particular behaviors and audiences (Abrahamse et al., 2007; Bolderdijk et al., 2013; Gromet et al., 2013; Huffman, 2009; Kahan et al., 2012; Osbaldiston and Schott, 2012). A further problem is the difficulty of teasing-out long-term impacts from experiments – where exposures are typically brief, and prone afterwards to dilution by many confounding effects. Through their jobs and/or interests we expect that the conservationists we sampled have experienced much longer-term exposure to environmental information than have other respondents. We therefore used our comparison of conservationists with other groups to examine associations between such exposure, environmental knowledge and pro-environmental behaviors, adjusting as far as possible for the effects of other factors.

By generating data on many different aspects of peoples' environmental footprints our survey also provides an opportunity to examine a third issue of considerable practical relevance: how far patterns of pro-environmental behavior co-vary across different domains. Are people that are pro-environmental in one aspect of their lives likely to be so in others, and are the predictors of different behaviors similar across domains? Evidence for such co-variation – for what has been termed the "pro-environmental consistency hypothesis" (Alcock et al., 2017) - is so far rather weak (e.g. Alcock et al., 2017; Barr et al., 2010; Kennedy et al., 2015; Painter et al., 1983). To the extent there are congruent patterns, interventions to shift behaviors could perhaps be generalised, but to the extent they are divergent, interventions probably need to be tailored to specific behaviors and groups (Alcock et al., 2017; Kennedy et al., 2015; McKenzie-Mohr et al., 1995; Osbaldiston and Schott, 2012; Painter et al., 1983). We thus used our measures of different pro-environmental actions to look at how far people behave consistently across behavioral domains, and at how far predictors of inter-individual variation show similarities across behaviors.

2. Materials and Methods

Between July and October 2015 we surveyed pro-environmental behaviors and their co-variates through an anonymous questionnaire (Appendix A). After piloting the survey iteratively with 36 undergraduate and graduate students at the Universities of Cambridge and Vermont and receiving approval from the University of Cambridge Ethics Review Group we distributed it electronically via conservation, economics and biomedical organisations to targeted newsletters, mailing lists and social media groups. Respondents were self-selected and thus (as in most studies of this nature) were a non-representative sample. We assigned respondents to our three groups simply based on whether they responded to a communication from a conservation, an economics or a biomedical organisation. The questionnaires were accessed and returned to us via SurveyMonkey (SurveyMonkey Inc., n.d.). Background socio-economic questions asked respondents about their gender, age, nationality, occupation, level of education, household income and size and level of charitable donations. We also asked respondents to rank the importance they attach to the environment (relative to education, the economy, healthcare and immigration; for analysis we reversed the ranks, so that 5=highest importance). We assessed knowledge about the environment by asking six factual questions about human populations, atmospheric change and species extinction; and knowledge about pro-environmental actions from a multiple-response question about how citizens could most effectively lower their carbon footprint.

Our key behavioral questions (Table 1) asked participants about several behaviors known to cause negative or positive environmental impacts: whether they walked, cycled or used public transport to get to work (Ercan et al. 2016); how often they flew (for work or personal reasons, which we analysed separately; Miyoshi and Mason, 2016); energy-saving measures in their homes (Dietz et al. 2009); whether they offset their energy or travel footprint (Gössling et al. 2009); their level of recycling and composting (Hermann et al. 2011); their production of food waste (Garnett, 2011); their consumption of meat or fish (Tilman and Clark, 2014); their use of bottled water (Botto et al. 2011); the number of children they have (or hope to have; Murtaugh and Schlax, 2009); and their ownership of cats and dogs (Ravilious, 2009). We also invited respondents to give reasons for their answers. Whilst the domains we selected do not enable us to carry out a comprehensive environmental footprint, they do give us a broad indication of respondents' relative environmental performance and allow us to investigate correlations between different behaviors.

Using self-reporting to estimate people's footprints means that impacts may be underestimated as a result of social desirability bias (the tendency to give answers that convey a favourable impression; Gatersleben et al., 2002: Kormos & Gifford 2014). However, here we are interested in a diverse range of behaviors (many of which are not amenable to more direct measurement – Abrahamse et

al., 2007), and are focused not on absolute impacts but on differences across individuals; we are therefore relying on the less extreme assumption that any biases are relatively consistent across respondents (but see Discussion). To tackle the related problem that some self-reported pro-environmental behaviors may have little beneficial impact (Bleys et al. 2017; Csutora, 2012; Kennedy et al., 2015) we used the literature and online calculators to estimate the difference in resulting greenhouse gas emissions of the 5th-percentile and 95th-percentile of respondents, when ranked for each behavior in turn (see Table 1; though note that this of course overlooks other components of the environmental footprint of these behaviors).

In total, 734 participants completed the questionnaire – 300 conservationists, 207 economists and 227 medics; 329 respondents were UK nationals, and 132 were US nationals. There were some similarities in the profiles of those sampled in each group (summarised in Table 2) – in median age, and income; but also some marked differences – in gender (with a higher proportion of male economists), nationality (fewer British economists, fewer US medics), occupation (fewer medics declared themselves as "practitioners"), education (more economists had PhDs), and charitable giving (medics on average donated a lower proportion of their salary than other groups). Unsurprisingly, conservationists ranked the environment as being more important to them than did economists or medics. As an aside, it is perhaps noteworthy that a year or so before the Brexit referendum and the Trump election 89.1% of all UK respondents and 94.0% of all US respondents listed the environment as more important to them than immigration – making clear that ours is certainly not a representative sample of society as a whole. This is underscored by all of our groups reporting numbers of children substantially below current cohort fertility rates (estimated at 2.0 and 2.3 for the UK and USA, respectively – Myrskylä et al., 2013).

We used a simple scheme (Table 1) to score participants' responses to each behavioral question, but to make subsequent analyses easier to interpret we reversed the scores for those behaviors that reduced people's footprints (lowering domestic energy use; offsetting; recycling). To look at overall behaviors we then generated a combined score, giving equal weight to each behavior (after combining work and personal flights into a single score). As potential predictors of variation in behaviors, we also calculated simple summary scores of respondents' environmental knowledge and knowledge of pro-environmental actions, and treated rank importance of the environment as a measure of its value to them (*sensu* Gromet et al., 2013). We analysed associations among response and predictor variables in two steps (as in Alcock et al., 2017), first using ANOVAs and correlations to assess simple patterns among knowledge and behaviors before building Generalized Linear Models (GLMs) to identify independent predictors of pro-environmental behaviors. To check the GLM results

were reasonably robust despite their relatively limited predictive power, we supplemented our analysis of variation in overall behavior with a model-averaging, information theoretic approach (weighting the coefficient of each predictor by the model weight and summing over all possible models; Burnham and Anderson, 2002).

3. Results

3.1. Do conservationists have a lower footprint than other people?

For some but not all the behaviors we considered, the conservationists we sampled had a smaller footprint than respondents from other groups (Fig. 1). They took fewer personal flights, did more to lower domestic energy use, recycled more, and ate less meat than either economists or medics. They also took fewer work flights and tended to have fewer children than did participating economists; and wasted less food and tended to offset their footprint more than did medics. However, the differences across groups were quite modest compared with the range of values seen across our sample as a whole (Table 1). Moreover, conservationists were similar to both other groups in how they travelled to work and in their use of bottled water, and (perhaps predictably) owned more cats and/or dogs than did economists or medics. The combined footprint scores across all behaviors were lowest for conservationists, then medics, and then economists (Fig. 1), although when work flights were excluded from the calculation (because these, it could be argued, are beyond the control of the participant), the difference between medics and economists disappeared ($F_{2,723}$= 15.71, $p<0.001$, with conservationist-medic and conservationist-economist differences significant at $p<0.05$).

In interpreting these patterns it is important to note that the behavioral domains we considered vary enormously in their environmental impact (Table 1, and squares above plots in Fig. 1), with estimated differences in resulting greenhouse gas emissions between those at the 5th and 95th percentiles for a behavior ranging across more than four orders of magnitude. The observed differences in bottled water use and recycling, for example, have almost no impact on overall emissions, while observed variation in domestic energy-saving, in meat-eating, in flying and especially in having children are associated with very substantial differences in people's footprints. Seen through this lens the better performance of conservationists in terms of personal flights, domestic energy-saving, carnivory and number of children is somewhat encouraging.

3.2. How important is knowledge in predicting variation in people's overall footprints?

The conservationists in our sample scored more highly for environmental knowledge than the medics, but not the economists ($F_{2,731}$= 11.56, p<0.001, with conservationist-medic and economist-medic differences significant at p<0.05). Conservationists also had marginally higher scores than medics but not economists for knowledge of pro-environmental actions ($F_{2,731}$= 7.18, p<0.001; conservationists vs medics, p=0.07; economists vs medics, p=0.001). Given that our three groups differed in other ways too (Table 2), to explore the extent to which knowledge predicts variation in footprints we next built a GLM of our respondents' combined footprint scores, and cross-checked the results via model averaging.

The GLM indicated that participants' combined footprint scores were higher for males, US nationals, economists, those with PhDs or (to a lesser extent) Masters degrees, and those with higher incomes (Fig. 2a). Income and being an economist had especially strong effects, as did an interaction term indicating that, for economists but not others, attaching high importance to the environment was associated with a markedly lower footprint (Fig. 2b). Footprint scores were also slightly lower (at p<0.1) for older respondents, and UK nationals. Importantly, controlling for the effects of other terms, there was no association between participants' combined footprint scores and their environmental knowledge, or knowledge of pro-environmental actions.

The overall explanatory power of the GLM was modest (pseudo r^2 = 0.17), although reasonable for an analysis of human behavior (see Abelson, 1985). However, our results were broadly similar when we adopted a model-averaging, information-theoretic approach, which combines the results from all possible models (Fig. A1, Appendix B; though note that the interaction term is no longer significant). Re-running the GLM with the combined footprint score modified to exclude work flights led to a weakening of the model (pseudo r^2 = 0.13), to the loss of the effects of education, age and to some extent gender, and to conservationists having a lower overall footprint than both medics and economists (Fig. A2, Appendix B). Importantly in none of these alternative model formulations was there any association between footprint scores and knowledge of the environment or of pro-environmental actions.

3.3. How far do behaviors co-vary across different domains?

We found only rather limited co-variation across respondents in their scores for different behaviors (Table 3). After adjusting significance values to account for making multiple comparisons, we found that only in a minority of cases did aspects of people's footprints co-vary positively. Individuals who

242 flew more for work also flew more for personal reasons. Those with more pets were more likely to
243 get to work by car. Those who recycled more did more to cut domestic energy use and also used less
244 bottled water, and those who used less bottled water produced less food waste. There were
245 negative associations too: respondents with more children undertook more actions to cut household
246 energy use, those who flew more for work offset their emissions more, and those who flew more for
247 personal reasons had fewer pets. However, all these correlations were relatively weak, and many
248 pairs of behaviors did not co-vary at all.

249 To explore how far predictors of inter-individual variation differ across behaviors, we built separate
250 GLMs for each behavior in turn (Fig. 3). These had limited predictive power, though each was
251 statistically significant, and together they revealed some interesting patterns. Attaching high value
252 to the environment, for example, was consistently associated with having a lower footprint: through
253 fewer personal flights, more offsetting, less food waste, and less meat consumption. The statistical
254 effect of other predictors, however, varied across behaviors. For instance, respondents with higher
255 incomes had more children and flew more for work and personal reasons, but they also took more
256 steps to cut domestic energy use. Likewise while older participants ate meat more frequently, and
257 had more children and pets, they also made fewer personal flights, undertook more energy-saving
258 measures, recycled more and were more likely to offset their emissions. Higher environmental
259 knowledge and knowledge of pro-environmental actions were both associated with a lower
260 footprint in how people get to work, but showed very limited links to any other behaviors.

261

262 **4. Discussion**

263 Our results suggest the following answers to our main questions:

264 1. Conservationists have a somewhat lower environmental footprint than economists or medics, but
265 this difference varies across behaviors, is not the case for travelling to work or pet ownership, and is
266 further weakened in GLMs that take into account socio-economic variation across our sampled
267 groups.

268 2. Variation in people's combined footprint is independently predicted by their gender, nationality,
269 occupation, education, income and the value which they attach to the environment – but not by
270 their environmental knowledge or knowledge of pro-environmental actions. Moreover, both our
271 knowledge measures are no greater among conservationists than economists.

3. Different components of people's environmental footprint are typically not correlated with one another, and show differing demographic patterns - with better paid or older individuals, for instance, having a higher footprint for some behaviors and a lower footprint for others.

These findings are of course subject to several important caveats. First, our respondents were a self-selected and thus non-random subset of the thousands of people who received invitations to participate in the survey. Our assessment of variation in their footprints relies on self-reporting, and therefore on the assumption that the biases this induces are similar across different groups. However, the validity of self-reporting varies (Kormos and Gifford, 2014), and it is possible that conservationists are disproportionately affected by social desirability bias because they know more about pro-environmental actions than (some) others and wish to convey a favorable impression of themselves. To the extent this is true it suggests the behavior differences between conservationists and our other groups are even less marked than we observed. Second, we considered only a fraction of all those behaviors with negative environmental impacts; to make participating relatively easily we measured most of them using fairly crude metrics (e.g. what forms of transport people used, rather than the distances covered); and we combined them without weighting them by their relative impact (though if we had done so, the results would essentially have replicated those for the number of children people have, given the overwhelming impact of this single behavior). Third and most importantly, our results are entirely correlational, greatly limiting our ability to understand the causality of the patterns we observed. Yet despite these caveats, because this is probably the first wide-ranging descriptive survey of the relative footprint of conservationists to date, we believe some cautious inferences can still be made.

Returning to our questions (but in reverse order), across our respondents as a whole there was limited covariation in different aspects of their footprint, with most behaviors we examined predicted by distinct (and sometimes opposing) combinations of socio-economic variables. Other studies have shown similar differences – especially in what predicts variation in different behaviors (e.g. Alcock et al., 2017; Barr et al., 2010; Kennedy et al., 2015; McKenzie-Mohr et al., 1995; Painter et al., 1983) or in the effects of interventions aimed at altering them (Abrahamse et al., 2007; Huffman, 2009; Osbaldiston and Schott 2012). As one example, in their assessment of people's environmental impacts on holiday, Barr et al. (2010) identified a group of richer, environmentally aware people who (like wealthier individuals in our own sample) take more personal flights than others but are also more likely to offset their emissions, and to adopt energy-saving actions at home. In addition we saw marked variation across behaviors in how conservationists compared with other groups (Fig. 1). We found no difference for the least important and perhaps most trivial behavior

(use of bottled water), but somewhat encouraging differences for some more deeply-rooted, higher-impact activities (such as meat-eating, taking personal flights, and having children) – in line, perhaps, with the idea that higher-impact behaviors are harder to shift (Abrahamse et al., 2007). Taken together these results underscore the importance of not assuming that people who are pro-environmental in one domain are necessarily so in others, and support suggestions that different approaches are needed to tackle different aspects of people's footprint (Abrahamse et al., 2007; Alcock et al., 2017; Huffman, 2009; Osbaldiston and Schott, 2012). Our results provide no indication that encouraging relatively easy but low impact behavioral changes (such as increased recycling) is likely to spill over into shifts in other domains, and we instead suggest efforts should focus on devising audience-specific interventions targeting those behaviors with greatest environmental impact. Meat consumption, flying and family size seem like important places to begin.

On our second question, we found almost no evidence that knowledge about the environment or of how to make a difference helps to promote pro-environmental behavior. Neither knowledge variable entered our GLMs predicting combined footprint scores (Fig. 2, Fig. A2), and they contributed to just three of 11 behavior-specific GLMs (Fig. 3), and then only weakly. Moreover, knowledge scores were no different between conservationists and economists (see also Kempton et al., 1995, cited in Kollmuss and Agyeman, 2002). Despite their presumably much more extensive exposure to information, conservationists didn't know much more, and knowledge cannot explain their somewhat lighter footprint. These results mirror those from other environmental studies (Bolderdijk et al., 2013; Csutora, 2012; Gromet et al., 2013; Hines et al., 1987; Jackson, 2004; Kollmuss and Agyeman, 2002; Li et al., 2016; Marteau, 2017; Steg and Vlek, 2009; St John et al., 2013; Sunstein and Reisch, 2014; Thøgersen, 2014; Vermeir and Verbeken, 2008) and from the health sector (e.g. Marteau et al., 2012) which indicate that the effects of income, social norms, habits, infrastructure and choice architecture may all be more important than knowledge in shaping our behavior. Indeed there is now growing observational and experimental evidence that among audiences with negative attitudes to the environment, greater knowledge and environmental messaging can even prompt a reduction in pro-environmental behavior (as seen in studies of the effects of pro-environmental product labelling on conservative consumers, and of the Pope's *Laudato Si* encyclical on conservative Catholics - Dietz et al., 2013; Gromet et al., 2013; Kahan et al., 2012; Li et al., 2016). Conservation education may instead have greater impact if it focuses on underlying values (which we found were more consistently linked to behavior than was knowledge; see also Bolderdijk et al., 2013). Improving conservationists' understanding of how to influence values - perhaps through providing formative life experiences (Chawla, 1998) – may be rewarding (but see Manfredo et al., 2016). Education aside, studies from other sectors strongly suggest that

conservationists could profitably do more to tackle structural constraints and choice architecture – both the absence of alternatives to high-impact behaviors, and the subtly counterproductive ways in which, when they are available, such options are often presented (Jackson, 2004; Marteau, 2017; Sunstein and Reisch, 2014; Thøgersen, 2014).

Finally, and closest to home, our results show that – while performing better on certain measures (include some that are high-impact) than do our other groups – as conservationists we could nevertheless do a great deal more to reduce our footprint. We think that trying to lead by example is key to encouraging and sustaining fundamental society-wide changes in behavior. Yet the average conservationist in our sample took three flights each year for work, plus three more for personal reasons; did nothing at all to offset their carbon emissions; and ate meat five times a week – while also listing the environment as their primary concern. As authors, we are every bit as hypocritical. Between the four of us we have seven children, took 31 flights in 2016, and ate an average of two meat meals in the week before submitting this paper. Being the change we wish to see in the world (to misquote Gandhi – Morton, 2011) will require us to make many potentially uncomfortable personal choices - about our family sizes and our diets, for example. But we suggest we must also take active steps as a movement and as a profession (Favaro, 2014). Obvious but challenging starting points could include changing the ways we interact, and measure our performance, so that attending frequent international meetings is no longer regarded as essential to making scientific or personal progress (see also Fraser et al., 2016; and the Flying Less initiative – Flying Less, n.d.); making these and other events we run free from ruminant meat or unsustainably-sourced fish; and offsetting our residual personal and professional footprints (preferably through creating and supporting projects that generate biodiversity co-benefits) rather than continuing to pass on the impacts of our choices to future generations and other species.

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Appendix A. Questionnaire. All respondents received an identical questionnaire, except that question 6 ("Do you consider yourself to be … a professional in the XXX sector, a XXX practitioner, a XXX researcher?") varied across groups, such that XXX read "conservation", "economics" or "biomedical", depending on the organisation through which the respondent was contacted. We present the conservationist version here.

Appendix B. Supplementary figures. These show the results of model-averaging (Figure A1), and the GLM of the combined footprint scores omitting work-related flights (Figure A2).

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530

531 Table 1. Summary of surveyed behaviors, how we scored them, and the range in scores and associated emissions reported in our sample.

Behavior	Scoring system	Footprint range			
		5%ile score	95%ile score	Difference (tCO_{2e}/y)*	Source and method
travelling to work	walk or cycle = 0, train or bus = 0.5, car = 1	0	1	2.1	Clear, n.d. assumes 15km each way commute in 2 year-old Ford Focus
flights per year (work and personal recorded separately)	≤3h = 1, >3h =2, with return trips counted as two flights	0 (work) 0 (personal)	20 (work) 16.7 (personal)	12 (work) 9.6 (personal)	Atmosfair, n.d. assumes ≤3h flight is London-Berlin, >3h flight is London-New York
*energy-saving measures at home^*	0.25 for each of insulation, changed temperature settings, double-glazing, and solar panels	0	1	6.0	CoolClimate Network, n.d.; Jones and Kammen, 2011; United States Environmental Protection Agency, n.d.; WWF-UK n.d.
*offsetting emissions from home energy use or travel^*	no = 0, partly = 0.5, yes = 1	0	1	2.3	Atmosfair, n.d. assumes full offsetting of all personal flights of median respondent
recycling (or composting) ^	approximate % recycled	0	100	0.25	United States Environmental Protection Agency, n.d. assumes recycle all paper, glass, plastic and metal
generating food waste	0.2 for throwing out over the past month any of a piece of fruit, a bag of salad, any leftovers, half a loaf of bread, or half a container of milk	0	1	2.2	WWF, n.d. assumes score of 1 corresponds to >30% food waste
consumption of meat or fish	rough number of meat or fish meals per week	0	14	8.4	CoolClimate Network n.d.; Jones and Kammen, 2011
use of bottled water	rough number of bottles bought per week	0	6	0.03	ELUA, n.d.
number of children	the number people have or hope to have	0	3	570	Murtaugh and Schlax, 2009 footprint of all descendants annualised across estimated 50y life as a parent, assuming constant emissions scenario and medium fertility variant
ownership of cats and dogs	number of cats and dogs owned	0 (cats) 0 (dogs)	2 (cats) 1 (dogs)	4.6	Rushforth and Moreau, 2013; assumes cats eat 50kg feed/y and dogs eat 100kg/y

532 ** difference estimates are absolute, and very approximate (and so reported to only two significant places); ^ to ensure higher-footprint behaviors*
533 *consistently received higher scores, in subsequent analyses we reversed scores for reducing domestic energy use, offsetting, and recycling*

534 Table 2.Socio-economic profile of our three groups of respondents.

		Conservationists	Economists	Medics
no. of respondents		300	207	227
% female		63.7	39.6	67.4
median age		43	40	37
nationality	*% UK*	57.3	33.3	66.5
	% US	23.7	23.7	5.3
	% other	19.0	43.0	28.2
occupation	*% professionals*	58.7	69.1	53.7
	% practitioners	41.7	58.0	19.4
	% researchers	44.7	76.8	53.7
education	*% PhD*	33.3	64.3	40.1
	% Masters	37.0	29.0	28.2
	% other	29.7	6.7	31.7
median household income/person (£/y)		22500	24200	25000
median % income to charity		5.6	5.6	3.3
median rank importance of environment		4.31	3.59	3.02

Table 3. Spearman rank correlations between the footprints of different behaviors across our 734 respondents. Bold denotes correlations which are significant at P<0.05 after Bonferroni correction for 55 comparisons. Scores for behaviors marked ^ were reversed (see text). Hence significant positive correlations indicate that individuals with a high footprint for one behavior had a high footprint for the other, while significant negative correlations indicate a high footprint in one domain was associated with a low footprint in the other.

	work flights	*personal flights*	*energy-saving at home†*	*offsetting †*	*recycling †*	*food waste*	*meat consumption*	*bottled water*	*no. of children*	*no. of cats and dogs*
travelling to work	0.01	**-0.12**	**-0.11**	0.00	0.01	**0.13**	**0.13**	0.03	**0.10**	**0.16**
work flights		**0.26**	**0.14**	**-0.13**	**0.10**	-0.05	0.02	**0.13**	0.03	0.06
personal flights			**0.16**	**-0.08**	**0.12**	0.04	-0.05	0.02	**-0.12**	**-0.14**
energy-saving at home†				0.06	**0.26**	-0.01	0.01	0.06	**-0.25**	**-0.13**
offsetting †					**0.08**	0.04	**0.10**	0.00	0.02	-0.01
recycling †						**0.15**	**0.15**	**0.14**	**-0.06**	-0.01
food waste							**0.10**	**0.15**	**0.09**	0.05
meat consumption								**0.12**	**0.11**	0.04
bottled water									**0.09**	0.00
no. of children										**0.11**

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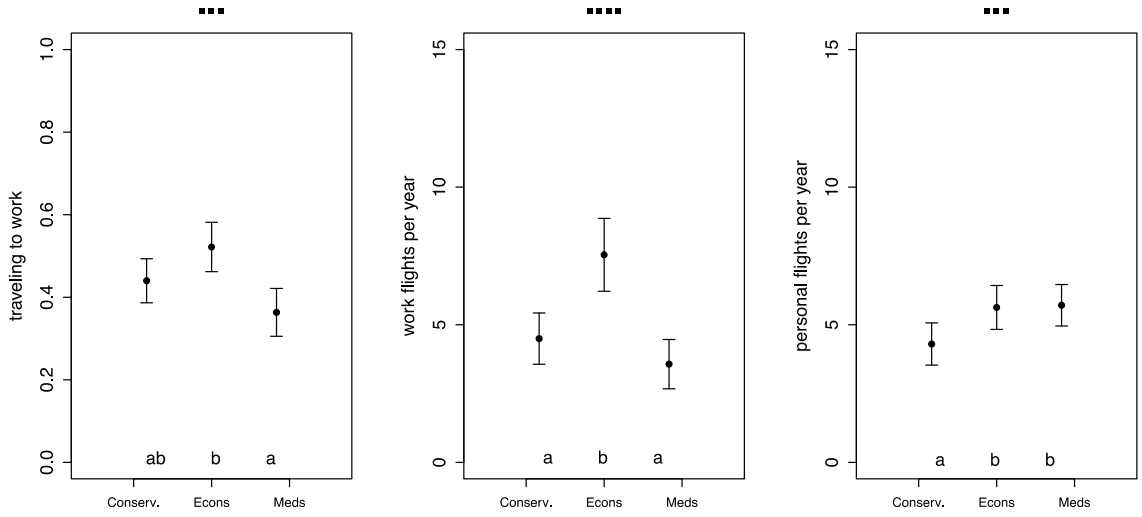
traveling to work
0.0
0.2
0.4
0.6
0.8
1.0
ab
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work flights per year
0
5
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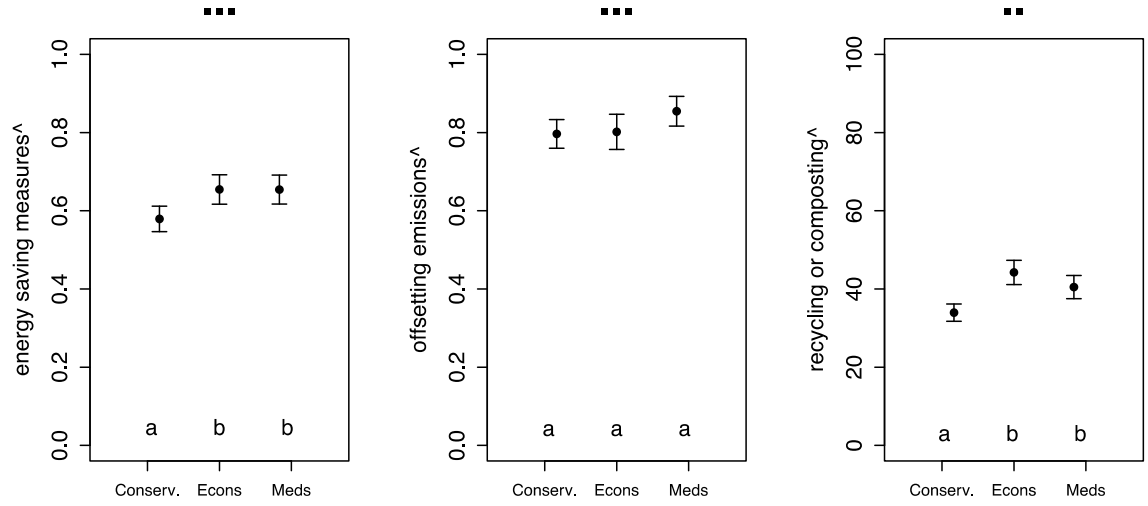
energy saving measures^
0.0
0.2
0.4
0.6
0.8
1.0
a
b
b
Conserv.
Econs
Meds
offsetting emissions^
0.0
0.2
0.4
0.6
0.8
1.0
a
a
a
Conserv.
Econs
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recycling or composting^
0
20
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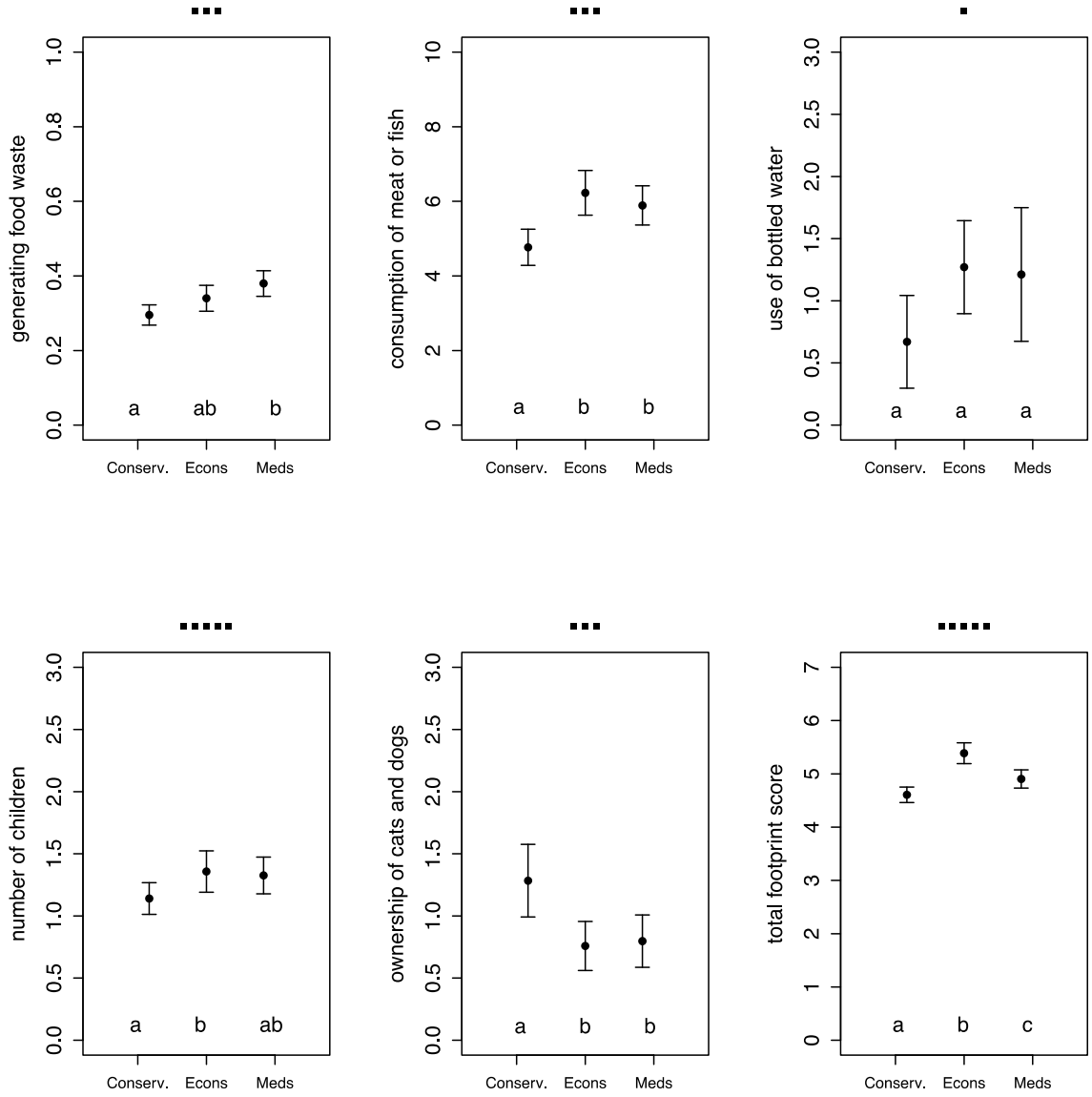

Figure 1. Footprint scores of conservationists, economists and medics compared, for 11 behaviors, and in total. For more detail on behaviors and how they were scored see Table 1. Plots show means and standard errors, with the range of y-axis values reflecting the span of scores seen in our data (Table 1). ANOVA results: for work travel $F_{2,731}$=6.58, P<0.01; work flights $F_{2,731}$=13.59, P<0.001; personal flights $F_{2,731}$=4.29, P<0.05; energy-saving measures^ $F_{2,731}$=6.23, P<0.01; offsetting emissions^ $F_{2,731}$=2.46, P=0.09; recycling or composting^ $F_{2,722}$=14.94, P<0.001; generating food waste $F_{2,731}$=7.34, P<0.001; consumption of meat or fish $F_{2,731}$=8.45, P<0.001; use of bottled water $F_{2,731}$=2.45, P=0.09; number of children $F_{2,731}$=2.73, P=0.07; ownerships of cats and dogs $F_{2,731}$=5.48, P<0.01; total footprint score $F_{2,723}$=20.79, P<0.001. Occupations that differ significantly in their footprint are shown by different letters. For three behaviors (marked with ^), scores were reversed so that (as with all other variables) higher scores denote a higher footprint. Filled squares above plots indicate the relative environmental impact of observed variation in each behavior, estimated simplistically as the difference in greenhouse gas emissions between those at the 5th and 95th percentiles of our sample for that behavior (▪<0.1 tCO_{2e}/y; ▪▪<1 tCO_{2e}/y; ▪▪▪<10 tCO_{2e}/y; ▪▪▪▪<100 tCO_{2e}/y; ▪▪▪▪▪<1000 tCO_{2e}/y; Table 1). 2-COLUMN IMAGE

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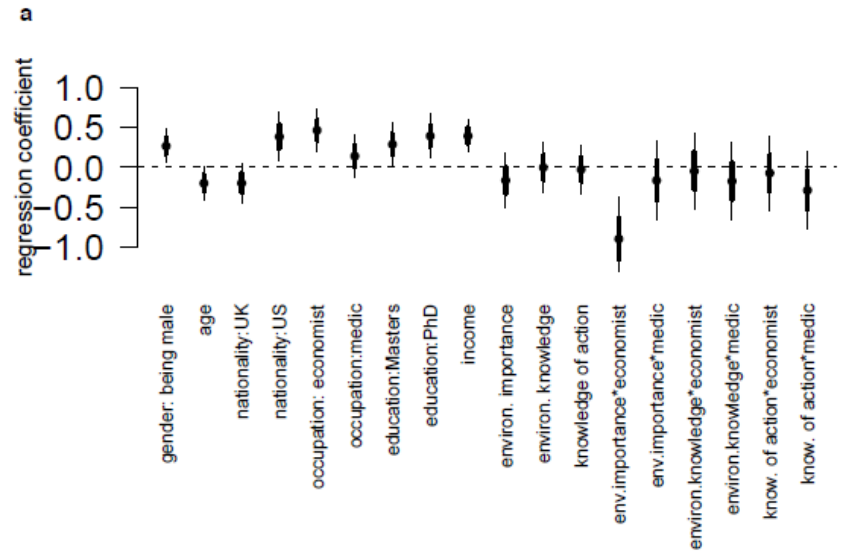

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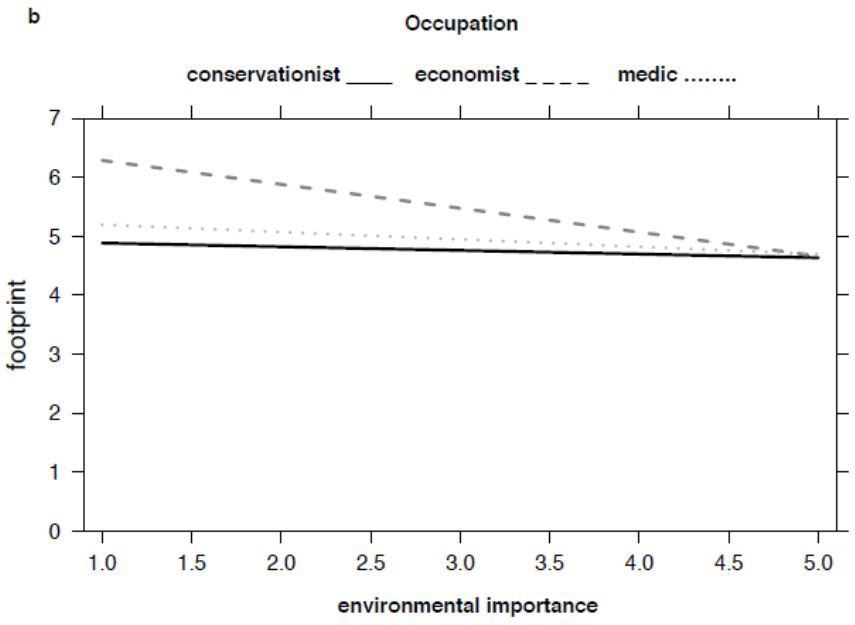

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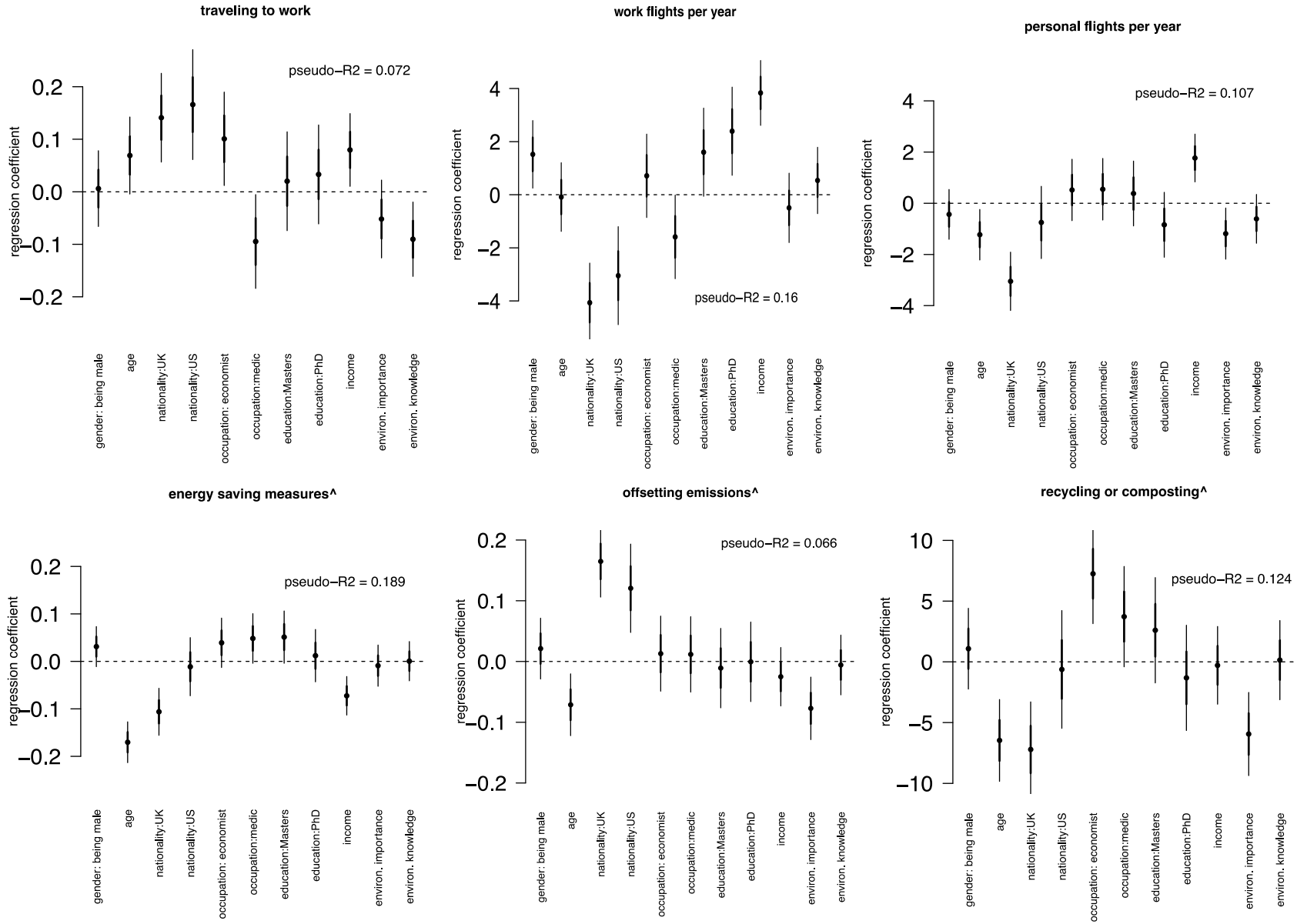
563 Figure 2. Results of the GLM predicting variation in participants' combined footprint scores, showing
564 (a) standardised regression coefficients for each term and their plausible two-way interactions; and
565 (b) the interaction between the effect of importance attached to the environment and that of
566 occupation. In (a) bars denote standard deviation and 95% confidence intervals for the coefficient of
567 each term's effect on combined footprint score, relative to that of a female conservationist from
568 outside the UK or US and with no university education. In (b) lines show fitted values.

569 1-COLUMN IMAGE


traveling to work
pseudo−R2 = 0.072
work flights per year
pseudo−R2 = 0.16
personal flights per year
pseudo−R2 = 0.107
energy saving measures^
pseudo−R2 = 0.189
offsetting emissions^
pseudo−R2 = 0.066
recycling or composting^
pseudo−R2 = 0.124
regression coefficient
gender: being male
age
nationality:UK
nationality:US
occupation: economist
occupation:medic
education:Masters
education:PhD
income
environ. importance
environ. knowledge

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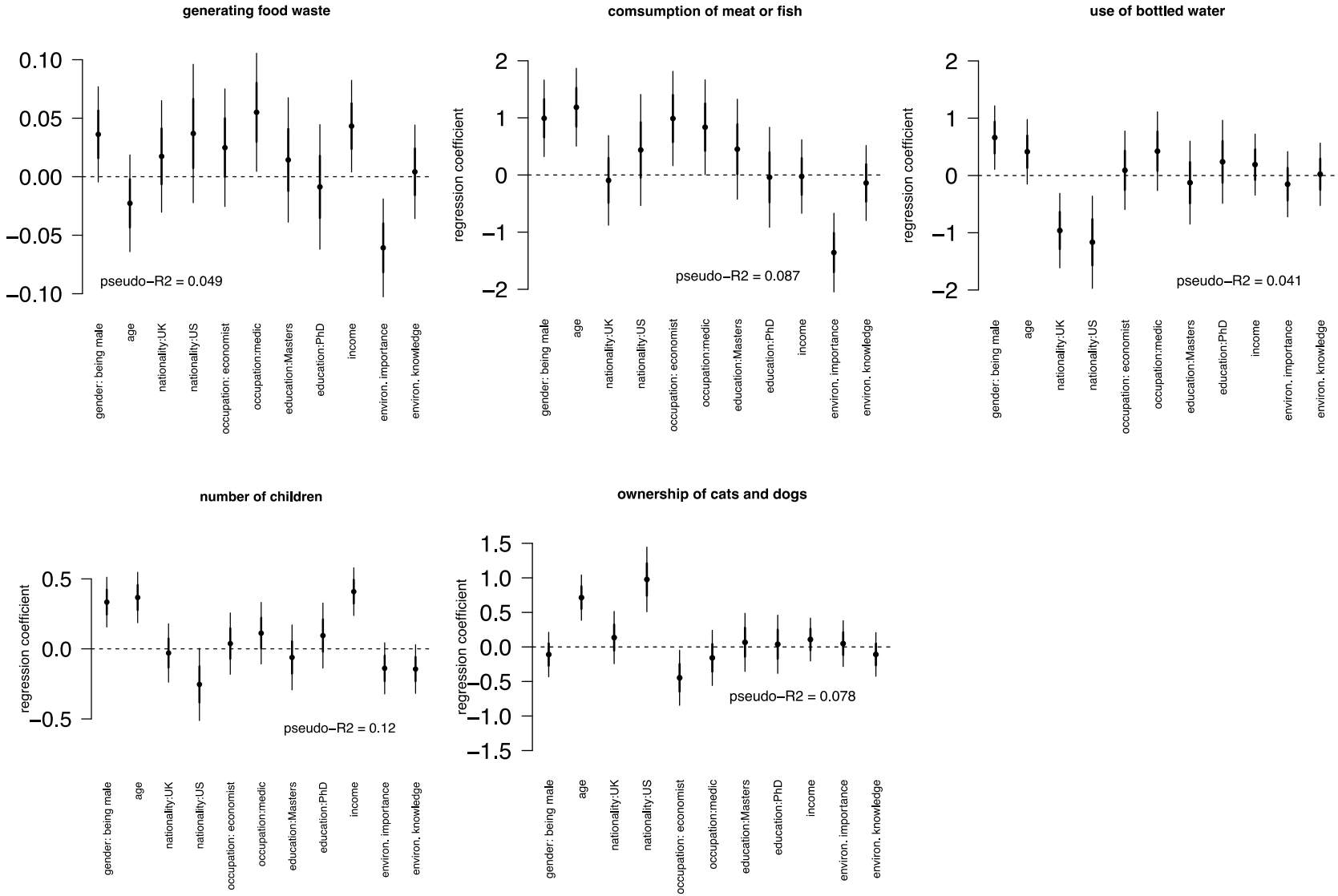

Figure 3. Results of GLMs predicting variation in participants' footprint scores across 11 behaviors showing standardised regression coefficients for each term. Bars denote standard deviation and 95% confidence intervals for the coefficient of each term's effect on combined footprint score, relative to that of a female conservationist from outside the UK or US and with no university education. 2-COLUMN IMAGE

The environment and you

Consent

Please give your consent to the information you provide being used for research. All uploaded information will be held anonymously with no names or other identifying features recorded, unless you wish us to contact you in due course with the survey results. You can exit the survey at any point, and incomplete survey data will not be uploaded.

***1. Do you consent to the information you provide being used for research?**

- ◯ Yes
- ◯ No

The environment and you

Welcome

Thank you for agreeing to take part in this survey. All responses will be treated entirely anonymously. Please answer all questions, as honestly as possible.

The environment and you

Section A: Some questions about you

Please answer every question and ensure you enter only numbers to questions that require numeric answers.

*2. Gender

- ◯ Male
- ◯ Female

*3. Age

*4. Nationality

	Country
In what country are you a full national?	

*5. Occupation

*6. Do you consider yourself to be any of the following?

	Yes	No	Not sure
A professional in the conservation sector	◯	◯	◯
A conservation practitioner	◯	◯	◯
A conservation researcher	◯	◯	◯

The environment and you

***7. Highest level of education completed**

- ◯ To age 16
- ◯ To age 18
- ◯ First Degree
- ◯ Masters
- ◯ PhD

Other (please specify)

***8. Approximate total household income per year (no commas please!)**

***9. Please give the currency**

- ◯ £
- ◯ $
- ◯ €

***10. Household size**

***11. How many children do you have (or hope to have) in total?**

You are already a third of the way through the survey!

***12. How many cats and dogs do you own?**

Cats

Dogs

***13. Approximately how much did your household give to charity over the past year (no commas please!)?**

***14. Please give the currency**

- ◯ £
- ◯ $
- ◯ €

The environment and you

***15. Please rank the following issues in order of importance to you (1= most important, 5= least important)**

	Education
	Economy
	Healthcare
	Environment
	Immigration

The environment and you

Section B: Your lifestyle

Please answer every question and feel free to use the boxes to give reasons for each answer. Again, please ensure you enter only numbers to questions that require numeric answers.

***16. For the most part, what method do you use to travel most of the distance to get to work?**

- ◯ Car
- ◯ Bus
- ◯ Train
- ◯ Cycle
- ◯ Walk
- ◯ N/A

Other (please specify)

17. Feel free to tell us why

***18. Many of us fly to places for work and/or pleasure. Roughly how many fights do you take in the average year (counting out + return as two flights)**

For work - 3 hours or less	
For work - more than 3 hours	
For pleasure - 3 hours or less	
For pleasure - more than 3 hours	

19. Feel free to tell us why

The environment and you

***20. Which of the following have you done to cut your domestic energy bills (tick all that apply)?**

- [ ] Added insulation
- [ ] Changed the temperature settings
- [ ] Installed double-glazing
- [ ] Installed solar panels
- [ ] Other measures
- [ ] None of these

The environment and you

21. Feel free to tell us why

***22. Do you offset the greenhouse gas emissions of your home energy use or travel?**

- ◯ Yes
- ◯ No
- ◯ Partly

23. Feel free to tell us why

***24. Thinking about the volume (number of bags or bins) you throw out each week, roughly what % of your waste do you recycle (including composting)?**

25. Feel free to tell us why

***26. Most of us throw away around 30% of the food we buy. Looking back over the past month, have you thrown out any of the following (tick all that apply)?**

- ☐ One or more pieces of fruit
- ☐ A bag of salad
- ☐ a meal you've bought or made (i.e. leftovers)
- ☐ Half or more of a loaf of bread
- ☐ Half or more of a container of milk
- ☐ Other items
- ☐ None of these

27. Feel free to tell us why

You are two-thirds of the way through the survey! Nearly there!

The environment and you

***28. Roughly how many of your week's meals contain meat (including fish and chicken)?**

29. Feel free to tell us why

***30. Roughly how many bottles of water do you buy in the average week?**

31. Feel free to tell us why

The environment and you

Section C: Your thoughts on environmental issues

Many of these questions could be answered using Google, but that would be boring - we're interested in what you think. Please answer every question. Like the previous sections, for questions that require a numeric answer, please ensure you only enter a number (with or without a decimal) in the answer box.

***32. Roughly how many people do you think live on Earth today (in billions)? (Hint: it's between 2.5 and 19.0 billion)**

***33. Roughly how much do you think the Earth has warmed over the past 100 years (in degrees Celsius)? (Hint: it's between 0.2 and 5.3 degrees Celsius)**

***34. Roughly what % of the world's bird species do you think are currently thought to be threatened by extinction? (Hint: it's between 2.0 and 37.0%)**

***35. Which of the following gases do you think has caused depletion of the Earth's ozone layer (tick all that apply)?**

- ☐ Carbon dioxide
- ☐ CFCs
- ☐ Methane

***36. Which of the following do you think currently threatens the greatest number of endangered species?**

- ◯ Overexploitation
- ◯ Habitat loss and degradation
- ◯ The spread of non-native species

***37. Which of these countries do you think has the highest rate of population growth (in % terms)?**

- ◯ UK
- ◯ Russia
- ◯ USA
- ◯ China

The environment and you

***38. Which of the following do you think would reduce the average US or UK citizen's carbon footprint by more than 4% (tick all that apply)?**

- [ ] Halving meat consumption
- [ ] Cutting flying by 80%
- [ ] Buying 80% of food from local producers
- [ ] Switching to low energy domestic appliances
- [ ] Recycling 80% of household waste
- [ ] Turning down the household's heating by 1 degree Celsius

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Thank you

Thank you for taking the time to complete this survey. Please now click 'Done' to record your responses. If you would like us to contact you in due course with the survey results, please also enter your email address in the box below. If you do decide to do this, your answers will remain anonymous.

39. Email

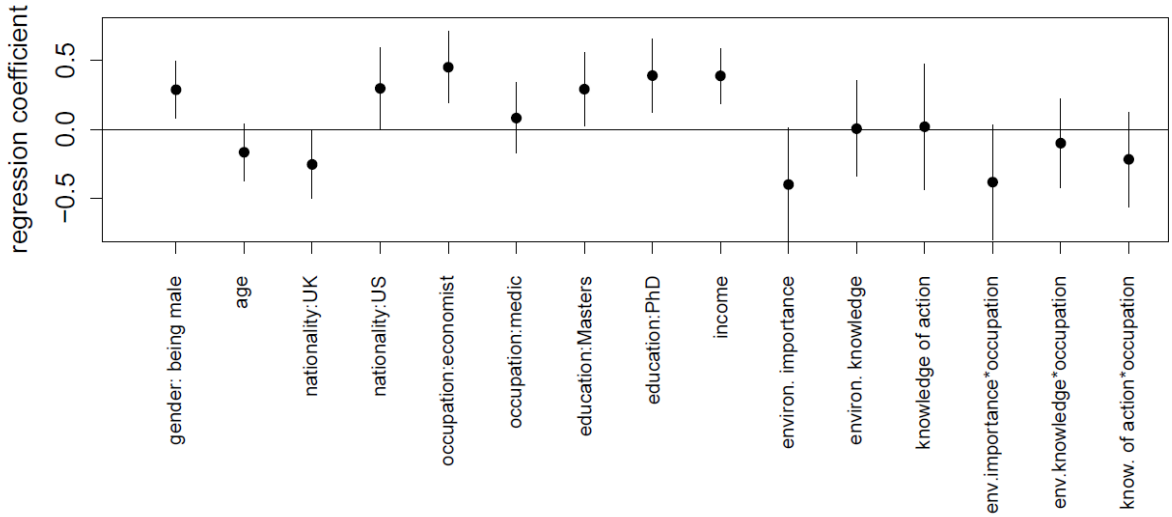

Figure A1. Results of the model-averaging procedure for predicting variation in participants' combined footprint scores, showing standardised regression coefficients for each term and their plausible two-way interactions. Bars denote 95% confidence intervals for the coefficient of each term's effect on combined footprint score, relative to that of a female conservationist from outside the UK or US and with no university education.

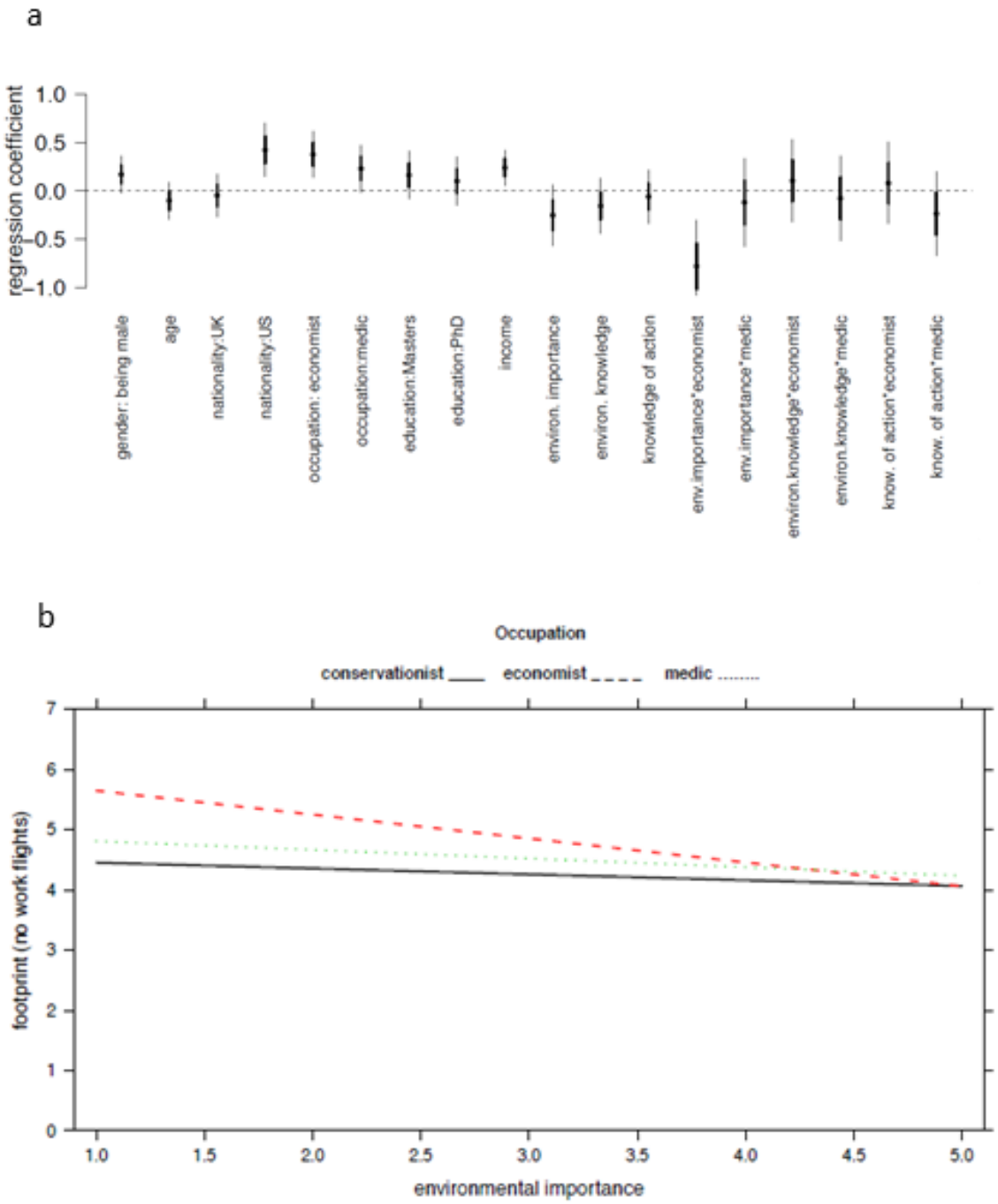

Figure A2. Results of the GLM predicting variation in participants' combined footprint scores, this time omitting work flights (which might be considered outside the respondent's control), and showing (a) standardised regression coefficients for each term and their plausible two-way interactions; and (b) the interaction between the effect of importance attached to the environment and that of occupation. In (a) bars denote 95% confidence intervals for the coefficient of each term's effect on combined footprint score, relative to that of a female conservationist from outside the UK or US and with no university education. In (b) lines show fitted values.